

IRRIGATION AND DRAINAGE ENGINEERING

ENAE 304

Lecture : 3
Tutorial : 1
Practical : 2

Year : III
Part : I

Course Objectives:

The objective of this course is to provide concept of planning, designing, developing, operating, and managing efficient irrigation and drainage systems, including both on-farm and off-farm components, as well as soil–water–plant interactions. It focuses on application of engineering, economic and automation techniques to optimize water use, enhance agricultural productivity and promote resource-efficient irrigation practices.

1 Water Resources and Irrigation in Nepal (2 hours)

- 1.1 Water resources potential and perspective in Nepal
- 1.2 Scope, advantages and disadvantages of irrigation
- 1.3 History of irrigation development and management in Nepal
- 1.4 Use of hydro-meteorological and climatic, soil and moisture, and socio-economic data in irrigation projects
- 1.5 Irrigation policy 2080

2 Planning and Development of Irrigation Projects (3 hours)

- 2.1 Irrigation system planning, feasibility studies and investigations
- 2.2 Development of irrigation projects; Command area development
- 2.3 Land grading, leveling and development
- 2.4 Environmental issues: Initial environmental examination (IEE), environmental impact assessment (EIA) and environmental management plan (EMP) of irrigation system
- 2.5 Conjunctive use of different water sources

3 Soil-Water-Plant Relationships and Irrigation Efficiency (6 hours)

- 3.1 Soil characteristics influencing irrigation: Mechanical composition, soil texture and soil structure
- 3.2 Soil water movement and soil moisture tension
- 3.3 Soil moisture constants and characteristics curve
- 3.4 Soil moisture measurements; Soil water extraction pattern in root-zone
- 3.5 Crop water requirements and crop coefficient
- 3.6 Evapotranspiration estimates: Empirical methods and Lysimeter
- 3.7 Field water requirement, effective rainfall and net irrigation requirements

- 3.8 Irrigation commanded area (GCA, CCA, NCA)
- 3.9 Duty, delta, base period, irrigation intensities
- 3.10 Irrigation scheduling: Full irrigation vs. deficit irrigation; Irrigation delivery at farm (Continuous, rotational, demand-supply)
- 3.11 Types of irrigation efficiency: Conveyance (Seepage and evaporation losses), application, storage and distribution; Irrigation water use efficiency, water use efficiency and economic water productivity

4 Irrigation Methods (4 hours)

- 4.1 Surface irrigation methods: Border, check basin and furrow irrigation
- 4.2 Hydraulics of border, check basin and furrow irrigation
- 4.3 Sprinkler, drip and sub-surface irrigation methods
- 4.4 Irrigation facilities powered by alternative energy sources

5 Conveyance, Distribution and Design of Channels (8 hours)

- 5.1 Canal classification by function and types
- 5.2 Canal irrigation system and its components; Canal alignment
- 5.3 Design of channels: Manning's uniform flow equation; Kennedy's silt theory and Lacey's regime theory
- 5.4 Alluvial and non-alluvial canals; Design of stable canals in alluvium
- 5.5 Canal lining, classification, economics and design of lined canals
- 5.6 Design considerations for hill and mountain irrigation
- 5.7 Design of sub-surface pipeline system

6 Diversion Headworks (6 hours)

- 6.1 River system in Nepal; Behavior of rivers
- 6.2 Selection of the suitable site for the diversion headworks
- 6.3 Layout of diversion headworks: Weir and barrage system
- 6.4 Design considerations of component parts of weir
- 6.5 Design considerations of component parts of barrage
- 6.6 River training works: Classification, components and design considerations

7 Irrigation Structures (4 hours)

- 7.1 Cross-drainage structures: Types, suitability and design considerations
- 7.2 Drop structures: Types, suitability and design considerations
- 7.3 Head, cross and escape regulators: Types, suitability and design considerations
- 7.4 Canal outlets: Types, suitability and design considerations

8 Agricultural Drainage (7 hours)

- 8.1 Water logging and management strategies for water-logged agricultural soil
- 8.2 Drainage requirement and investigation in farm

- 8.3 Hydraulic conductivity and drainage coefficient
- 8.4 Drainage methods and suitability: Surface, sub-surface and bio-drainage
- 8.5 Design considerations, layout and construction for surface drainage system
- 8.6 Design considerations and layout of sub-surface (Tile drainage) system
- 8.7 Vertical drainage and skimming wells
- 8.8 Sustainable drainage system in urban agriculture
 - 8.8.1 Concept of sustainable drainage/ low impact development
 - 8.8.2 Drainage for urban agriculture/ water sensitive urban design
 - 8.8.3 Parkland irrigation and drainage

9 Irrigation Management, Automation and Economics (5 hours)

- 9.1 Irrigation system management; Participatory irrigation management
- 9.2 Asset management plan
- 9.3 Governance in irrigation system and its importance in management
- 9.4 Operation and maintenance of irrigation system
- 9.5 Design of an intelligent irrigation system
- 9.6 Dry-land agriculture irrigation automation
- 9.7 Economic analysis of an irrigation project

Tutorial (15 hours)

- 1. Calculation of depth and frequency of irrigation
- 2. Estimation of PET by Penman and modified Penman methods
- 3. Design of an earthen stable canal
- 4. Design of an alluvial canal
- 5. Design of a lined canal
- 6. Design of weir
- 7. Design of siphon
- 8. Design of distributary head regulator
- 9. Design of semi-modular and non-modular outlets
- 10. Design of pipe irrigation system
- 11. Design of surface and sub-surface drainage system
- 12. A typical case study of irrigation efficiency

Practical (30 hours)

- 1. Estimation of field capacity using SMC vs time method
- 2. Field evaluation of crop evapotranspiration using Lysimeter
- 3. Irrigation water requirement calculation using CROPWAT 8.0
- 4. Flow measurement using notches, weirs, Parshall flume, H-flume and cut-throat flume
- 5. Observation and evaluation of check basin irrigation
- 6. Observation and evaluation of boarder irrigation
- 7. Observation and evaluation of furrow irrigation
- 8. Observation and evaluation of drip irrigation
- 9. Observation and evaluation of sprinkler irrigation

10. Determination of hydraulic conductivity in the field and laboratory for drainage investigation
11. Determination of water quality parameters for suitability of irrigation

Field Visit

One-day field visit to a nearby irrigation project, presentation and report submission.

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Marks distribution*
1 and 2	5	5
3	6	8
4	4	4
5	8	12
6	6	8
7	4	8
8	7	10
9	5	5
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Garg, S.K. (2023). Water Resources Engineering Vol. II: Irrigation Engineering & Hydraulic Structures. Khanna Publishers.
2. Modi, P.N. (2019). Irrigation Water Resources and Water Power Engineering. Standard Book House.
3. Michael, A.M. (2008). Irrigation Theory and Practice (2nd Edition). Vikas Publishing House.
4. James, L. G. (1988). Farm irrigation system design. New York: John Wiley & Sons.
5. Reddi, G. H. S., Reddy, T. Y. (2005). Efficient use of irrigation water. Kalyani Publishers.
6. Vos, J. (Ed.). (1987). Proceedings, symposium 25th international course on land drainage: Twenty-five years of drainage experience (Vol. 42). International Institute for Land Reclamation and Improvement.
7. Laar, D. (1996). Crop-water-plant relationships. International Institute for Hydraulic and Environmental Engineering.